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Are You Saved? HIM, an Intranet-Based Expert System Reduces Fatality Risk

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Are you saved?

HIM, an Intranet-based Expert System Reduces Fatality Risk.

Introduction

On July 28, 1998 a devastating accident occurred at the Test Reactor Area of the Idaho National Engineering and Environmental Laboratory (INEEL). The accident cost a man his life and caused injury to others. In addition to the significant human loss, Lockheed Martin (LMITCO) experienced economic losses that reached millions of dollars. LMITCO eventually lost the managing and operating contract of a premier Department of Energy Laboratory.

Just as with the INEEL, companies throughout industry today must face an ever increasingly complex world of government alphabet soup of regulations—OSHA, CAA, TSCA, FIFRA, ADA, and more. For businesses, non-compliance can quickly evaporate profits. For humans, mistakes can seriously affect health, and some work areas are so complicated that a single event could cost human life. Finally, adherence to the regulations can protect the community and the environment.

Compliance with regulations is essential and multifaceted. Regulations require interpretation into company policy. Policies must be implemented as standard work practices. The workforce must be trained to follow the procedures. Management must coordinate flow down of requirements and policy for standardized work planning processes and consistent compliance with regulations.

Implementing controls to ensure absolute compliance can be a very costly and cumbersome effort, thus, a graded approach is necessary to ensure cost effectiveness and relevance to actual work.

The INEEL has developed technology for hazard evaluation and work planning called the Hazards Identification and Mitigation System. The HIM System is a web-based expert system that is available to all INEEL employees through the company Intranet. This tool simplifies and streamlines work planning by using a graded approach to standardize practices. The tool assists in evaluating hazards and ascertaining the required rigor for planning work. The tool integrates the knowledge of INEEL and DOE experts and previously proven review checklists and processes.

A project manager said the following regarding the HIM System:

> “The system is a very important partner in the process of developing work orders; in fact it is so important to the planning

process that without the electronic method, planning will slow to a crawl. It should be noted that there is a mechanism in STD-101 to create a Hazards Profile manually. However, that means evaluating 178 to 200 questions (60 to 80 pages two sided for each work order). This involves going over those pages by hand to determine the hazards."

The manual process is lengthy—sometimes taking 12 to 18 hours to complete. As such, it is difficult, prone to errors, and very tempting to shortcut. Automation of this process through the HIM system reduced a monumental hazard-identification task for each work order, into a streamlined, efficient, and accurate process that can be completed in less than one hour.

The result is that the process gets done, the regulations are met, and risk to human life is reduced.

History

The history that lead to the development of the HIM Process is two pronged. First, in 1993, development of the multidimensional process model began. Second, in 1996, the Enhanced Work Process (EWP) was developed.

Multidimensional Process Model

The multidimensional process model was initially developed as a response to an effort to improve cost effectiveness in project management. It was determined that a consistent method for establishing the proper project criteria for all of the identified project-management activities was needed. The traditional one-dimensional, cause-and-effect model was deficient mainly because ignored many significant interconnections and scenarios.

The model is part of a four-step technique for the development of an expert system. The first step is to develop an expert knowledge base. The second step is the creation of the multidimensional model. This step requires the concurrent development of six key elements—activities, influence factors, magnitudes of influence, interconnections, scenarios, and criteria. The multidimensional model consists of activities on the x axis, influence factors on the y axis, and magnitudes of influences on the z axis. The interconnections between influence factors and magnitudes of influences are engineered to establish scenarios defined by the experts. Thus, in multidimensional modeling, the design includes multiple causes that result in multiple effects.

The third step is to format the decision-tree logic. Each scenario is used to develop a list of decision points (questions) required to generate the scenario. The questions are then arranged into groups of similar subjects, and each group is evaluated to establish a hierarchy of the questions, so that asking a single question could eliminate the need to ask another question or questions.

The final step in the technique is to computerize the expert system. This was done through the use of object-oriented expert-system software. The use of object-oriented development tools allowed the final product to be easy to change, which reduced the dependency upon programmers and allowed the system to be left in the hands of the experts.

The benefits of the multidimensional model and the four-step technique include the assurance of consistent compliance with applicable regulations, the incorporation of expert knowledge into a computerized system, the consistent application of rigor to an activity, the creation of expert system without programmers, and the ability to make changes to expert systems in hours or days rather than weeks or months.

Enhanced Work Process

The first attempt to automate the work process began as a rudimentary DOS-based system known as Job Requirements Checklist (JRC). This system did nothing more than facilitate the determination of who should review work orders. The next iteration incorporated a process that essentially rose red flags to help identify hazards and reviewers for those hazards.

Later, a web-based expert system was born as part of an Enhanced Work Process (EWP). This system incorporated the functionality that had already been developed, and enhanced its ability to identify hazards by utilizing the JRC. It also tied in to company enterprise systems for forms and procedures.

This is when the accident occurred. Accident evaluations revealed that the workers did not use the JRC, and it is likely that the accident would not have occurred had the JRC been used. The questions that would have identified the fatal risk were in the existing hazard-identification system, however, it is not known whether the reviewers would have been accurately led to those questions.

The accident led to a number of corrective actions that include the following:

1. Provide additional guidance on the performance of hazard analysis to include the importance of capturing all potential and credible hazards associated with the work or workspace and the significance of risks created by the hazards.
2. Revise the JRC to include criteria regarding emergency preparedness input, reviews, and approvals; standardize the process for identifying potential and credible hazards for the job; and enable the JRC to provide general directions for hazard mitigation requirements.
3. Develop and implement requirements to maintain a controlled list (hazards analysis database) of known building or area-specific hazards, and standardize mitigation barriers for each building or facility; and require planners to incorporate the applicable information from the list into each work order.

In October of 1998 the Site Operations Director of the INEEL commissioned the development and implementation of a Maintenance Integrated Work Control Process (IWCP) manual to implement a Site-wide standardized process consistent with principles of Integrated Safety Management System (ISMS). This IWCP provides for a foundation for management to identify and communicate standards, requirements, and expectations to employees involved in performing maintenance and construction work at the INEEL. It also significantly increases the use and effectiveness of the Hazard Identification and Mitigation Process

Development of the HIM System

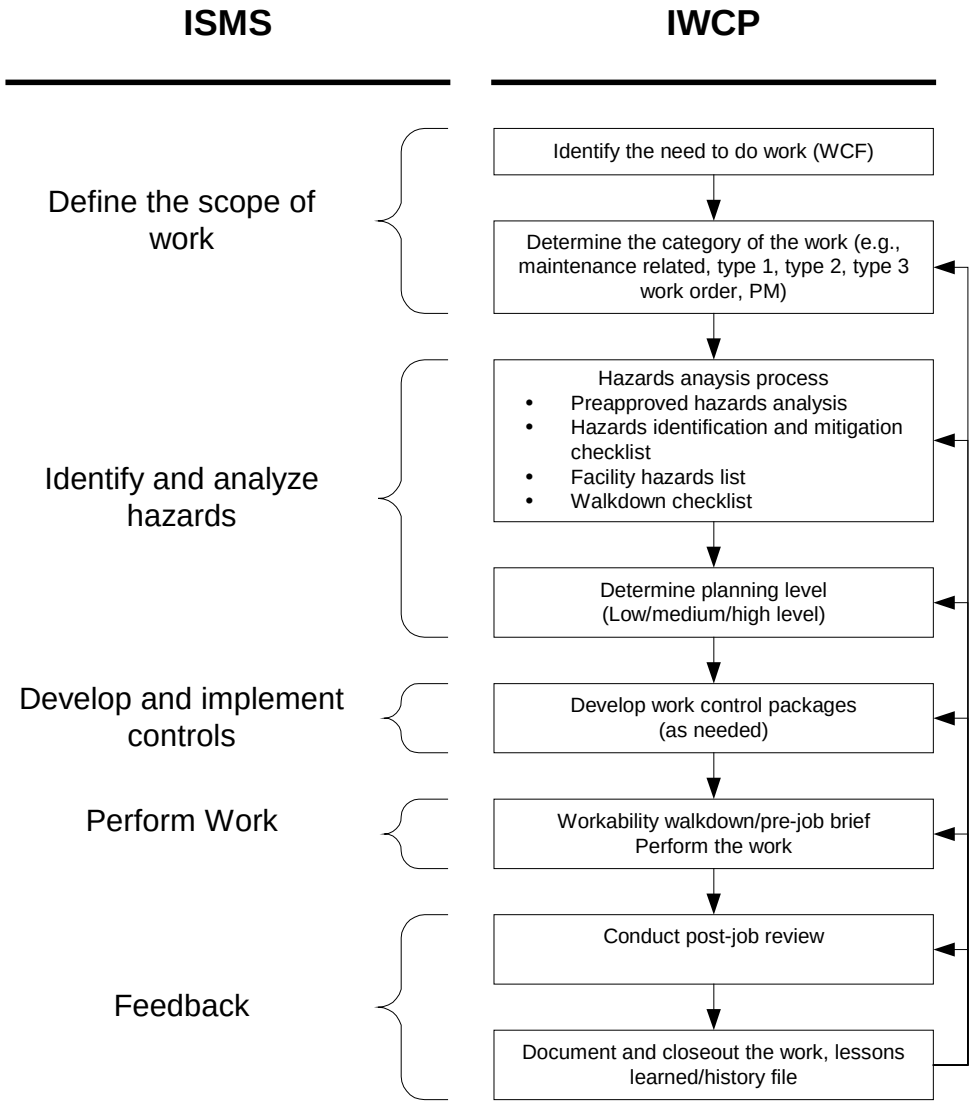
A key to the success of the HIM System is not just that it is a powerful web-based expert system, but also that the system is encapsulated within the Integrated Work Control Process (IWCP), which parallels the DOE-mandated Integrated Safety Management System (ISMS).

ISMS combines all the elements of environment, safety and health into one ES&H system that is focuses on accomplishing work safely, rather than ES&H requirements and programs for their own sake.

ISMS includes five core functions that are tightly integrated into the IWCP. These functions are as follows:

1. Define the scope of work
2. Analyze the hazards
3. Develop and implement hazard controls
4. Perform work within controls
5. Provide feedback and continuous improvement

Each step of the core functions of ISMS is addressed with one or more steps of the IWCP. See the following figure.



A significant lesson learned was to make the process work on paper first, then to implement it electronically. The first step in the development process was to evaluate the existing paper process at Rocky Flats. A number of the features of the Rocky Flats process were incorporated into a new paper-based system called the Integrated Work Control Process (IWCP).

The paper-based system provided a mechanism to work out the kinks of the process and to get the process going. However, inherent in the paper-based system were problems such as configuration control, and the time requirements to complete the checklists were enormous.

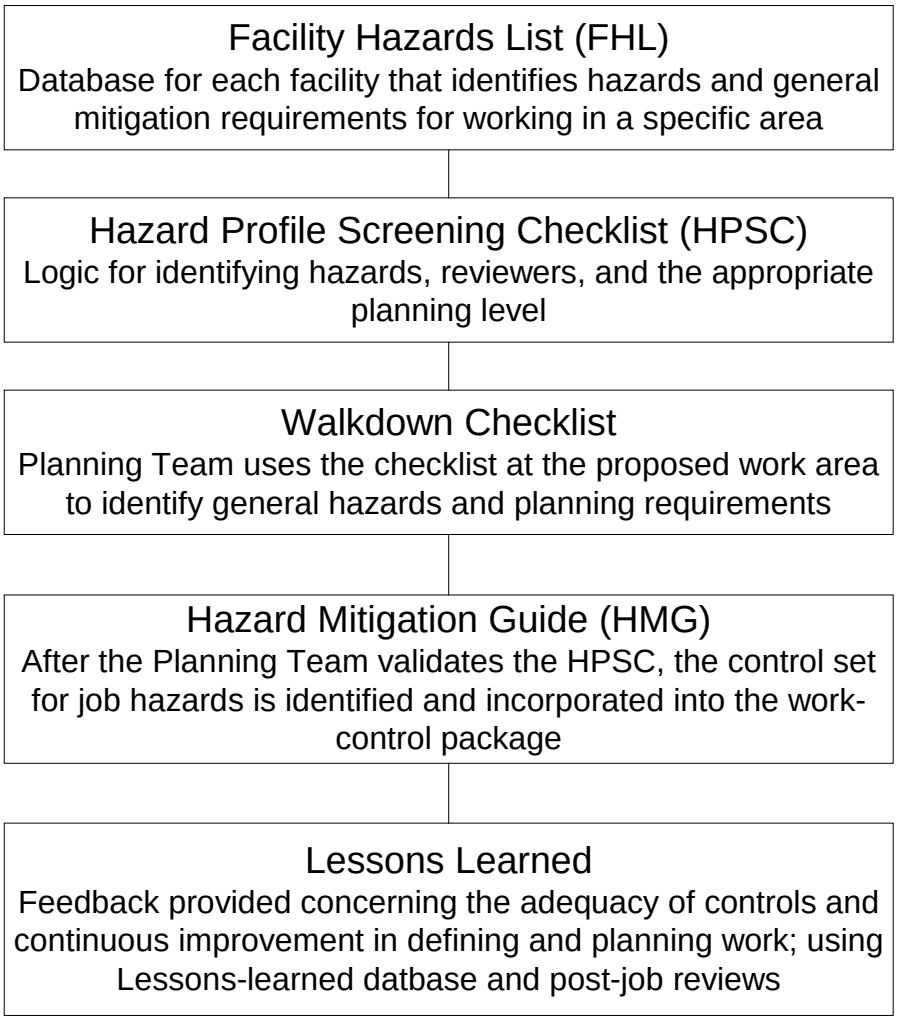
The next step was to develop the web application and database.

The creation of the new automated Hazard Identification and Mitigation (HIM) System was project based and used techniques espoused by the previous Enhanced Work Process (EWP) system. A key success factor for the development of the HIM Process was the diversity and commitment of the development team who created the functional criteria and developed the review questions. The team included the users of the previous JRC process (planners, system engineers, crafts, and foremen), subject matter experts representing each ESH&QA discipline, security, programmers, construction, operations, and line management. In all, over 12,000 man-hours went into the development of the HIM System. This level of effort was afforded to the project based on senior management's recognition and support that the HIM System would serve as the hub toward implementing ISMS and VPP (Voluntary Protection Program) into daily maintenance and construction work activities.

Although the diversity of the team presented its own problems with varying opinions and approaches, involvement of the key decision makers, or "experts" was absolutely essential to success. These experts included Site Maintenance Managers from each site area.

Overview of the HIM System

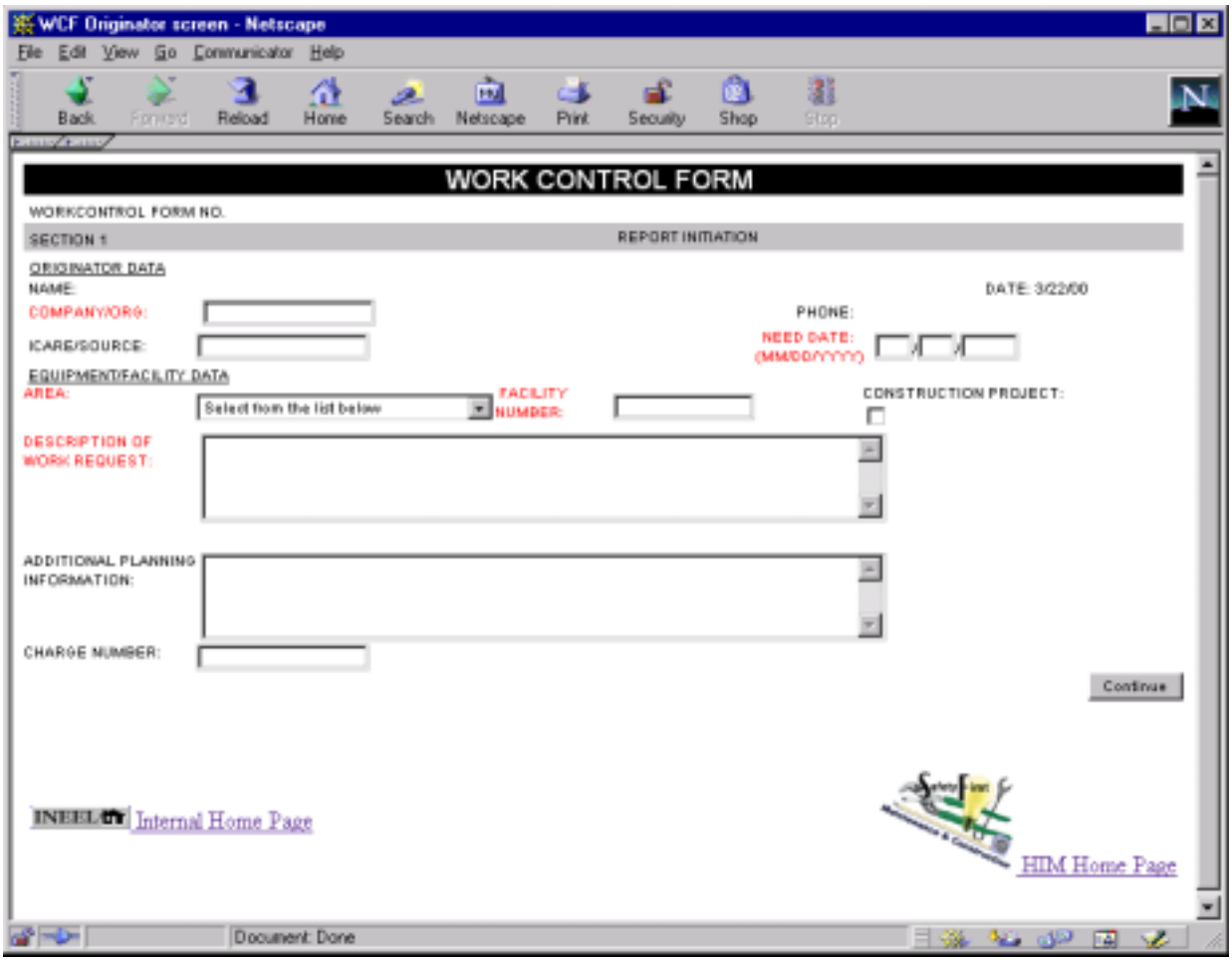
The HIM System automates the first four blocks of the IWCP, which was originally developed as an all-paper process. In addition, HIMS facilitates the final block of IWCP by allowing for the continual addition and refinement of information within the database. This expert system consists of a series of logical questions that combine the Facility Hazards List database, Hazards Profile Screening Checklist, and Hazard Mitigation Guide into an output report that provides a job-tailored customized checklist to be used by the planning team to develop the work-order package. See the following figure.



HIMS provides a standards-based approach to identifying hazards and mitigation requirements. It assists the user in evaluating hazards, and in determining the required rigor for planning work, and the mitigation actions necessary for the development of the Hazards Control Set.

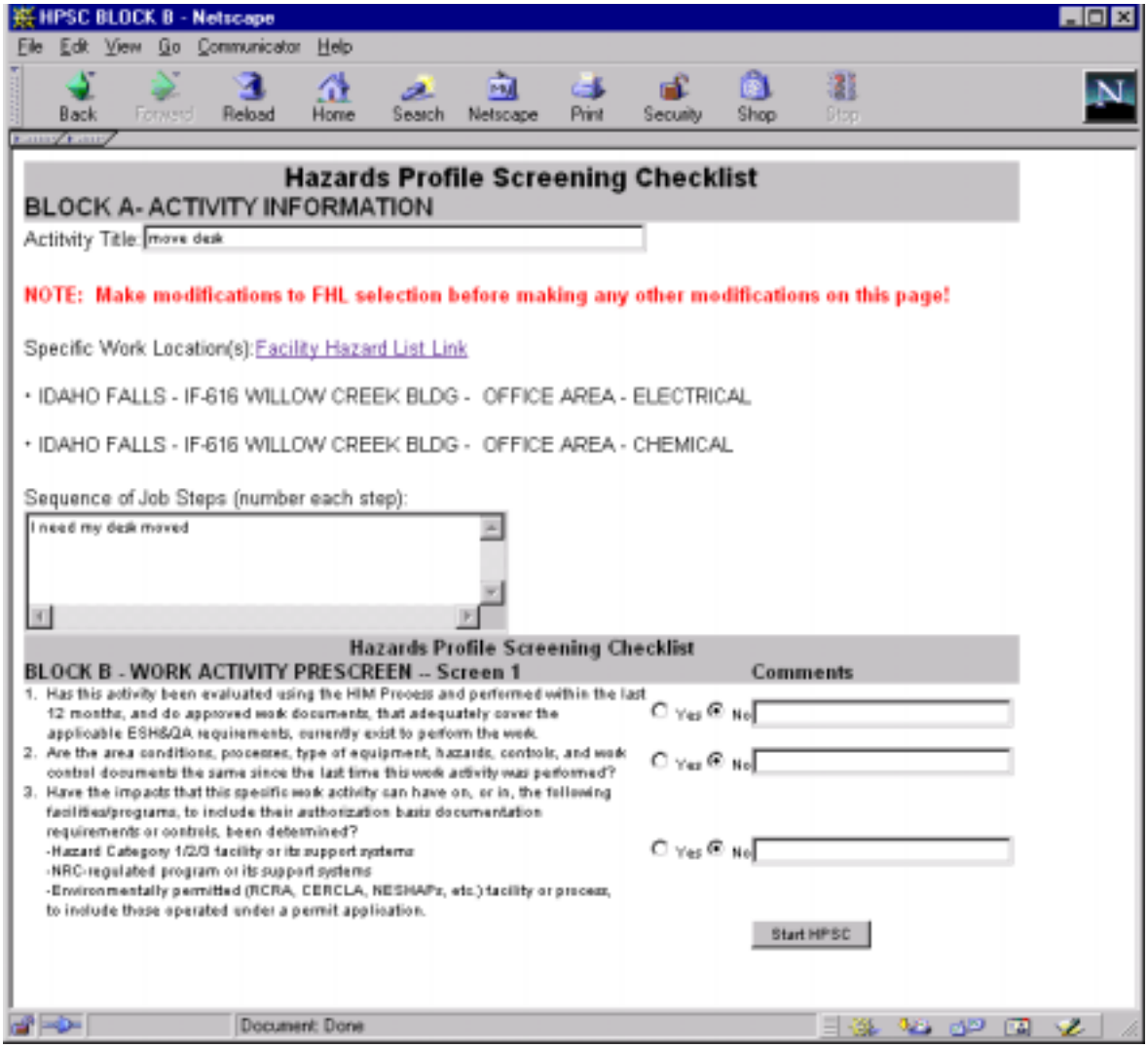
Work Request

The process starts when a work request is generated. HIMS provides a web-based work control form (WCF) that is accessible to any person with access to the INEEL Intranet (see the following figure). From here, users submit work requests that are then forwarded to operations for approval.
Once approved, a planning supervisor determines the routing in a work control system. The Primary Owner uses the Facility Hazards List (FHL) and the Hazards Profile Screening Checklist (HPSC) to perform the initial analysis of hazards.



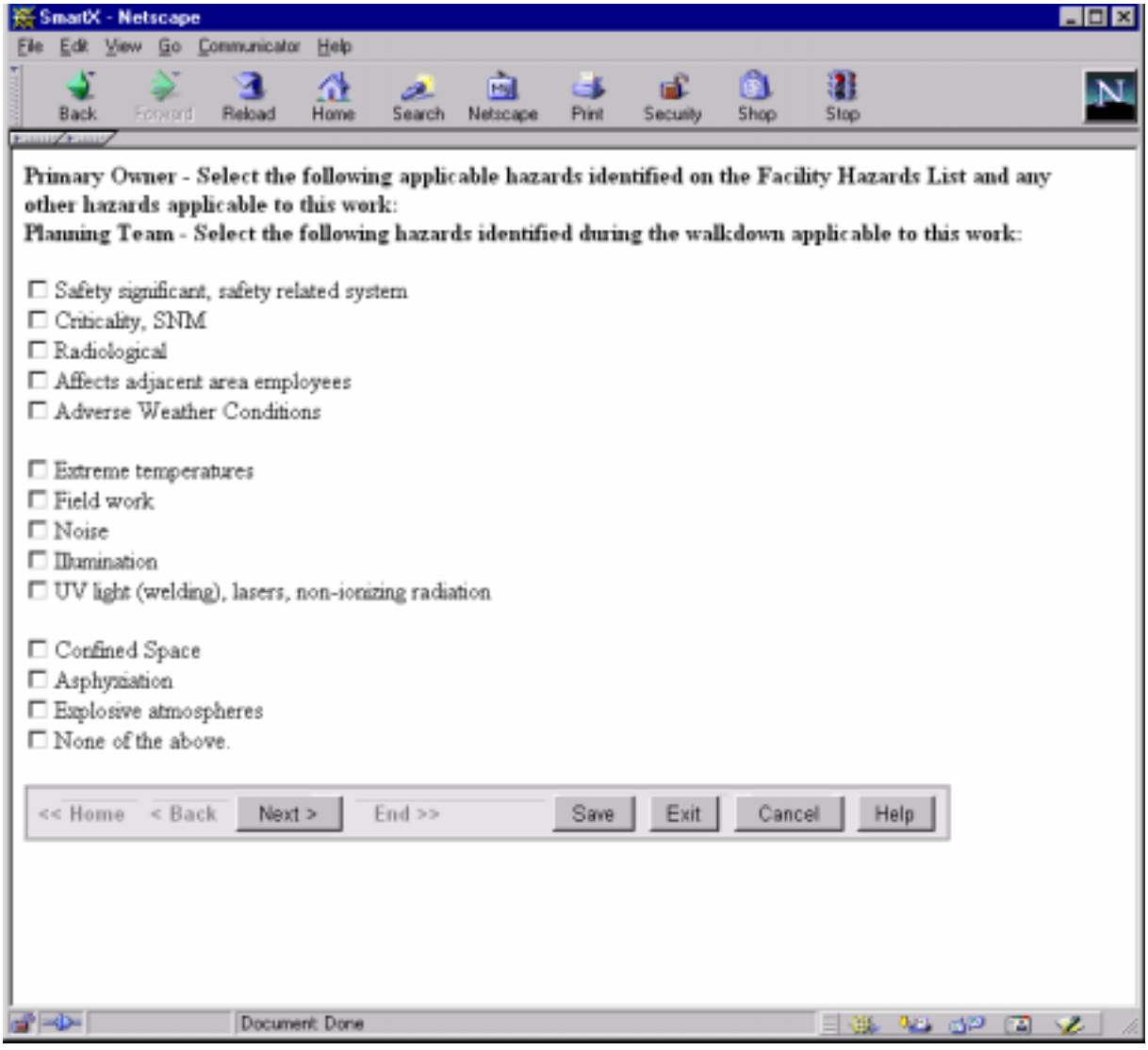
Facility Hazards List

The Facility Hazards List is a database that contains known general hazards for all facilities throughout the site. The HIM system guides the user through identifying all applicable locations for the work to be performed. HIM then inherits all relevant hazards from the FHL and incorporates it into the final report.



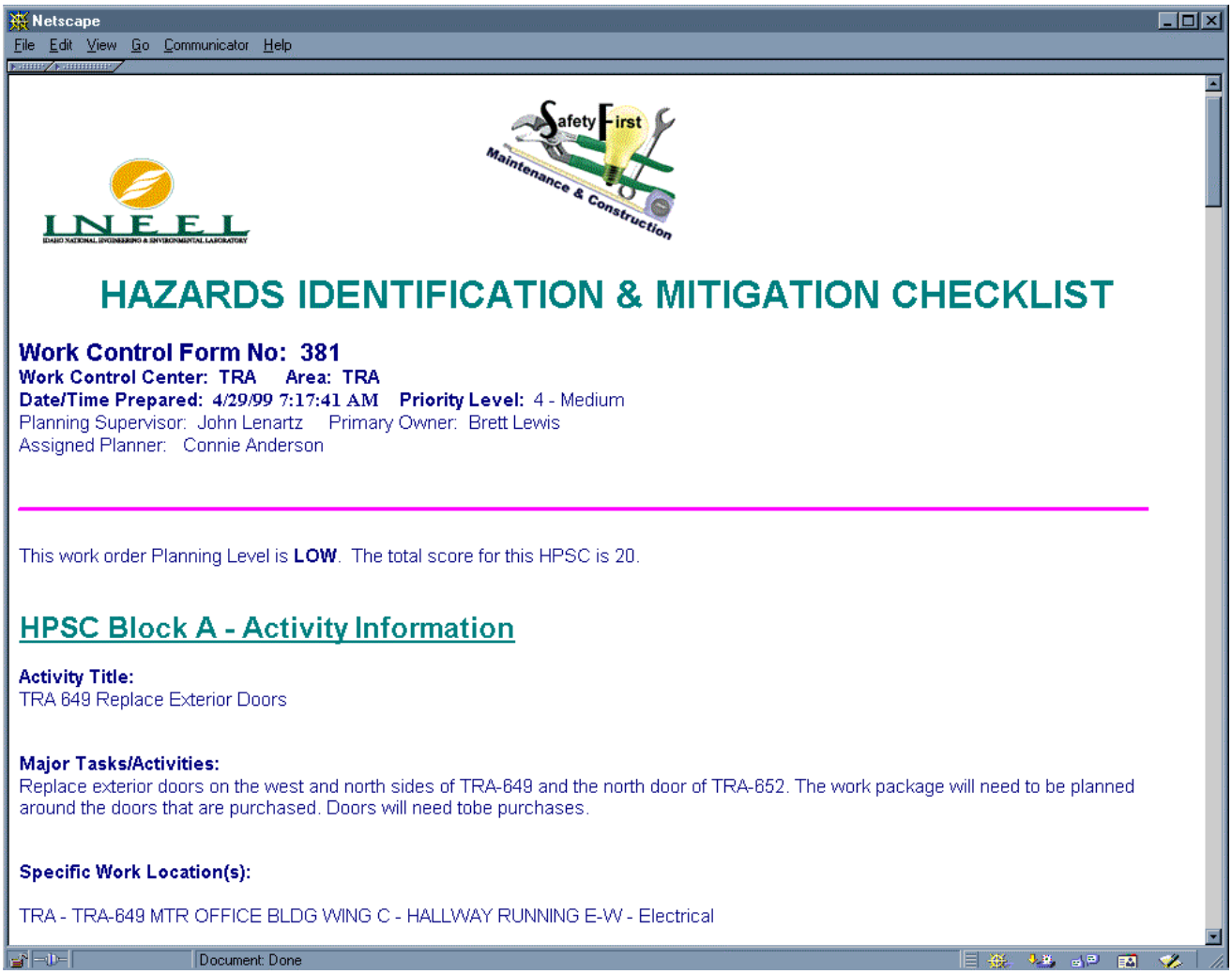
Hazard Profile Screening Checklist

The Hazard Profile Screening Checklist is a dynamic questionnaire that develops each set of questions based on information from three areas, first, from the work control request form, second, from the database of expert knowledge regarding hazards, and third, from answers to previous questions. The result is a web-based interview with a virtual expert that extracts from the user, the necessary information to evaluate hazards. The interview is tailored to the specific work effort, thus it eliminates overburden for the simple work orders, while at the same time it ensures complete coverage for complex work orders.



Hazard Report

The output of the HIM System is a comprehensive report of the hazards that incorporates information from the original request, facility hazard information, and a compilation of hazard information learned from the expert interview.



The output of the report can vary greatly and is dependent upon the information in the expert knowledge base. The report contains four blocks of information, which include a summary block that provides a total score and planning level for the work effort.

Block A—Activity Information

This section identifies general information about the work effort to be performed. It includes information about each work location and the general known hazards that are associated with that area.

Block B—Work Activity Prescreen

The second section identifies additional information about the work activity that essentially identifies the scope for the remaining analysis.

Block C—Preliminary Hazards Profile

This section establishes a profile of all hazards related to the specific work effort. It includes information regarding the review requirements. Additionally, it contains hazard information that is broken down by types of hazards such as radiological, electrical, and chemical. For each type of hazard, the report identifies the training that is necessary to deal with the hazard and the controls that are necessary to mitigate the risks of the hazard.

This section also identifies forms and other relevant documentation for the work effort. This information is listed as hyperlinks so that report readers can link directly to forms- and document-management systems for direct access to the latest version of documentation.

Finally, this section summarizes training that is required to mitigate the identified hazards.

Block D—Planning Process Screen

This section summarizes the entire hazard report. In addition, it assigns a point value to each relevant issue and provides a total score. Based on the score, the rigor of the required planning is rated.

Final Steps

Once the report is developed, it is used as a primary tool to assist in a development of the total work package, and the physical walk down or pre-job briefing.

Once the work effort is completed, the HIM System facilitates the gathering of lessons-learned information for incorporation into future efforts.

Benefits of the HIM Process

The final implementation of the system was in April of 1999. Initial feedback and observations have identified several benefits as a result of implementing the new automated HIM Process.

First, the Facilities Hazards List database is available to all INEEL personnel to allow them to determine hazards in an area in which they plan to enter. Second, the maintenance and construction planners both use the same methodology for identifying and mitigating hazards. Third, the intensive training to implement the program improved the effective implementation of ISMS and VPP. Fourth, the flow-down of compliance to requirements into work orders is thoroughly identified and implemented. Finally, the subject matter experts have an extensive

centralized listing of required mitigation responses to expected work hazards thereby ensuring a consistent approach to ensuring worker safety.

This technology can be applied to solve maintenance work hazard identification and mitigation planning problems for complex petrol-chemical, nuclear, waste management, construction, manufacturing, and other related industries that are required to ensure the safety and health of their employees and the protection of the neighboring community and environment.